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# **Recent Activities of the Marshall Space Flight Center Natural Environments Branch Terrestrial & Planetary Environments Team**

March 2017 Natural Environments  
Day-of-Launch Working Group Meeting

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MSFC Natural Environments Branch/EV44



# Exploration Mission-1 (EM-1) Support

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- EM-1 Launch planned for late 2018
- There are three programs under the Exploration Systems Development Division (ESD) at NASA HQ working toward the launch
  - Space Launch System (SLS)
  - Orion Multi Purpose Crew Vehicle (MPCV)
  - Ground Systems Development and Operations (GSDO)
  - Also, ESD has a Cross-Program function to ensure all the programs are integrated for the EM-1 launch



# ESD Natural Environment Cross-Program Function

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## Cross-Program Natural Environments Integration Ad-Hoc Team

SLS-SPEC-159 Cross-Program Design Specification for Natural Environments (DSNE)  
SLS-SPEC-044-07 Cross-Program Vehicle Design Environments Vol. 7: Natural Environments

### MSFC Natural Environments Branch/EV44

#### ESD

Point of  
Contact  
(MSFC)

#### GSDO

Natural  
Environments  
Lead  
(KSC)

#### Orion MPCV

Natural  
Environments  
Lead  
(MSFC)

#### SLS

Natural  
Environments  
Lead  
(MSFC)

Exploration Systems Development (ESD)  
Ground Systems Development and Operations (GSDO)  
Marshall Space Flight Center (MSFC)  
Multi-Purpose Crewed Vehicle (MPCV)  
Space Launch System (SLS)

# Cross-Program Support Activities

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- The Exploration Mission 1 (EM-1) Launch & Recovery Program Requirements Document is under review by SLS and Orion
- SLS-SPEC-159 Cross-Program Design Specification for Natural Environments (DSNE) Rev. D is being updated to Rev. E
  - New Appendix B Validation Matrix
  - Updates to several Space Environments sections
  - Update a gust model for the winds aloft environment
  - Addition of KSC coastline/water depth information (for pad and near-pad aborts)
- SLS-SPEC-044-07 Cross-Program Vehicle Design Environments Vol. 7: Natural Environments will be updated this Summer
  - Reference the new DSNE Rev. E
  - Add Orion Wave Model
  - Add description of specialized environment definitions (e.g., KSC Seasonal Atmospheric Profile Triplets, KSC Monthly and Annual Mean Wind and Atmosphere Profiles, etc.)

# Orion/SLS Launch Day Support Activities

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- Providing support to the Day-of-Launch Initialization-Load Update (DOLILU) development activities
- Continue to support the development of natural environment related Operational Maintenance Requirements (OMR) & Launch Commit Criteria (LCC)
- Continue to lead the Meteorological Support Interface Control Working Group (MSICWG)

# Draft Launch Wind LCC

Lightning Protection System Level	Height AGL (feet)	Height AGL (meters)	Direction (degrees)	1-min Peak Wind Speed (knots)	1-min Peak Wind Speed (meters per second)
<b>A</b>	132.5	40.4	0 - 360	29.1	<b>14.9</b>
<b>B</b>	257.5	78.5	0 - 360	34.2	<b>17.6</b>
<b>C</b>	382.5	116.6	0 - 360	37.6	<b>19.4</b>
<b>D</b>	<b>457.5</b>	<b>139.5</b>	<b>0 - 360</b>	<b>39.3</b>	<b>20.2</b>

(1) Time Period: From the start of Core Stage Cryo Tanking to Launch

(2) During the hold at T- 10 minutes, the Launch Weather Officer will provide the forecasted winds for the launch pad through T-0.

If the forecast violates any maximum redline in the Measurement/Requirement Table above, then the LCC violation is confirmed, No Go for launch.

(3) If real time events cause the Launch Weather Officer to revise the forecasted winds after T – 10 minutes, but prior to T – 33 seconds, and the revised forecast violates any maximum redline in the Measurement/Requirement Table above, then the LCC violation is confirmed, No Go for launch.

## NOTES:

(1) At the time of launch, the surface peak winds shall not exceed the limits at any level specified in the Measurement/Requirement Table above.

(2) The surface winds shall be a 1-minute peak wind supplied by the Launch Weather Officer for Launch Complex (LC) 39-B.

(3) The wind speeds shall be obtained from the meteorological instrumentation located at 132.5, 257.5, 382.5, and 457.5 ft levels on the LC 39-B Lightning Protection System.

(4) The measurement from the meteorological instrumentation located on the LPS tower up-stream from the launch pad, relative to the direction of the wind, is preferred to evaluate this constraint. This will allow the measurement to be taken in the ambient free-stream environment, un-obstructed by the structures of the launch pad.

## DRAFT RATIONALE:

(1) The surface peak wind constraint protects for surface peak wind design limits specified in “SLS-SPEC-044-07 Cross-Program Space Launch System Program Vehicle Design Environments Volume 7: Natural Environments”, Section 3.3.2.

(2) The values in the Measurement/Requirement Table above were determined from the Space Launch System analysis of how ground winds during vehicle liftoff affect acoustic and vibration environments. The surface wind limits are needed to prevent exceedance of SLS Vehicle vibration qualification levels.

(3) The surface wind requirement for Orion MPCV umbilical is 35.9 knots, steady-state, at 317 ft above ground level. The current surface wind limits in the table above are more constraining than the Orion MPCV umbilical limit. If the surface wind limits are ever relaxed, the Orion MPCV umbilical limit must be considered to ensure no exceedances of the limit during liftoff.

# Draft Launch Wind LCC

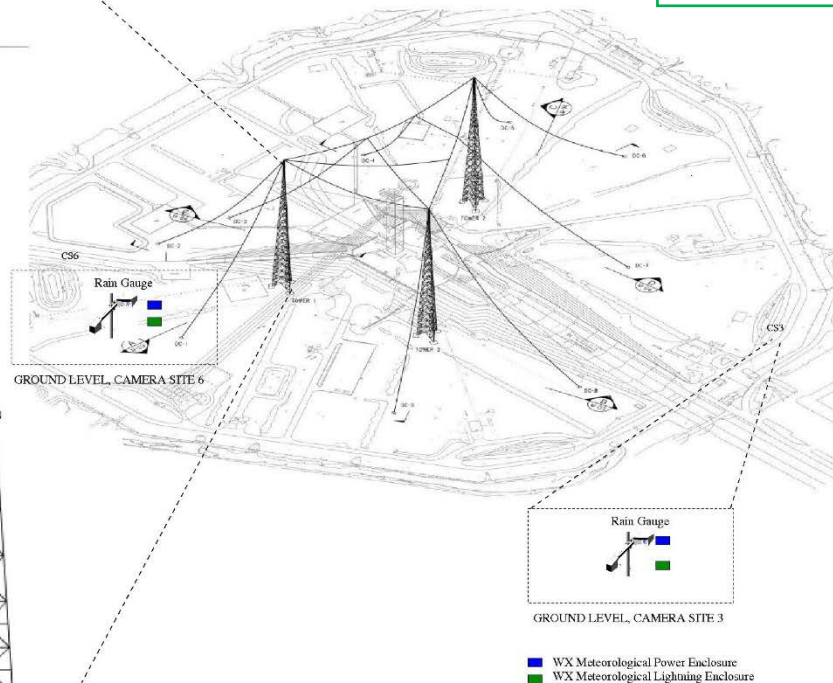
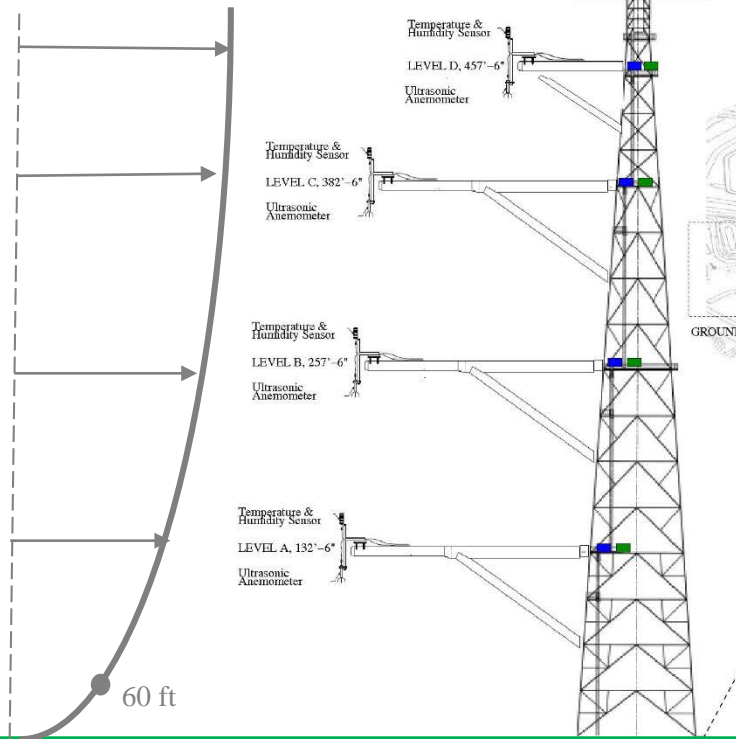
## Design Ground Peak Wind Curve

### Weather Instruments

Level A 132.5 ft (40.4 m)  
Level B 257.5 ft (78.5 m)  
Level C 362.5 ft (110.5 m)  
Level D 457.5 ft (139.5 m)

TYPICAL LIGHTNING PROTECTION TOWER  
WITH METEOROLOGICAL INSTRUMENTATION

WEATHER INSTRUMENTATION (WX) SUBSYSTEM  
LC 39B METEOROLOGICAL ARCHITECTURE



## Other Activities

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- Earth Global Reference Atmospheric Model (GRAM) version 2016 was released in December 2016
  - Code change from FORTRAN 90 to C++
  - Now publically available software
- In the process of updating Mars GRAM to C++
- Provided in-sight support Commercial Crew Program
- Continued archival of terrestrial data from KSC/Eastern Range
  - Primarily consisting of data passed through the Range External Interface Network (REIN)
  - Do in-house quality control of most of the data before archiving
  - Looking into new data formats to replace the old MDTF format